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ATTENTION

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Since the last summary in the BULLETIN[1] of the literature on attention, many studies have appeared, which may, for the purposes of this review, be divided into 4 groups: (1) those that are concerned with the ultimate nature of the phenomenon; (2) those that deal with some definite aspect of the problem,—such as the conditions of attention, the range, fluctuation, or measurement of attention; (3) those that treat of the relation of attention to other phenomena; and (4) those that are technological,—that were undertaken because of the practical applications.

1. NATURE OF THE PHENOMENON

In a paper presented at the Strasbourg meeting of the French Association for the Advancement of Science in 1920, Foucault (14) attacks the faculty conception of attention, which, though long abandoned by scientific psychology, recurs all too frequently to-day. The traditions of language and thought are so strong upon us that we commonly treat attention as a complex faculty, as the application of the will to the intelligence. Foucault shows that nothing comparable to this concept exists: (1) that the effects of practice and fatigue cannot be explained in terms of attention; (2) that the depth of an impression in memory does not depend upon the degree of attention; (3) that an attentive perception cannot be explained by attributing it to attention, but only by analysis which lays bare

[1] PILLSBURY, W. B., this BULLETIN, 1920, 17, 259–260.

the elementary facts and laws; (4) that individual differences and variations in the same individual are not due to changes in the energy of the faculty; and (5) that what are called attention and inattention are characteristic states, resultants, and not creators or distributors of psychic energies.

Piéron (25), in discussing Foucault's paper, says that he believes the concept of attention, evolved in the attempt to explain the mental efficiency of an individual at a given moment, is a hazardous one; and that he therefore regards the criticisms brought forward by Foucault as very important and fertile.

d'Allonnes (2), considering the higher forms of attention, discusses in order (1) apperceptive attention of which two forms, the natural and the artificial, may be distinguished; (2) conceptual attention, described as that which for the interpretation of ideas makes use of concepts; (3) attributive attention, of which four forms may be distinguished; and (4) rational attention. The article closes with a discussion of the significance of these forms.

The motor aspects of attention are treated in Tuttle's (27) study of the effect of attention or mental activity on the patellar reflex. By means of special apparatus, the patellar tendon is struck at a constant intensity and a uniform rate, and kymographic records are made of the resulting knee jerk. During "passive" periods, the subjects—of whom there were seven, all normal—sit as quietly as possible with eyes closed; during "active" periods, they are directed to solve some problem. The results are uniform for all the subjects; the average height of the knee jerk is 9.91 times larger under "active" conditions than under "passive."

Tuttle concludes that mental activity increases muscle tonus, and that muscle tonus is either (*a*) one of the factors in the attentive process, (*b*) a function of the attentive process, or (*c*) the process of attention itself. He seems, however, to favor the last alternative, since he argues from the results of two records, which show a gradual rise and fall in the height of the knee jerk during an "active" period, to the probability that the curve of attention is "one in which there is a gradual rise in tonicity to a maximum, and then a gradual fall until the problem has been completed."

These conclusions rest on the assumption that attention is an increased tonicity of the muscles which adjust the body to the reception of stimuli and of the muscles through which the response is expressed.

2. Special Aspects

A. *Conditions of Attention:* Dallenbach (7) describes a piece of apparatus that has been evolved in the Cornell Laboratory for the study of the conditions of clearness; and he reports an experiment (8), performed with this apparatus, on the effect of position as a determinant of attention. Position, he finds, conditions clearness: the position to the left of and above the point of fixation has an attentional advantage, and the most favored position of all is that to the left of and below the point of fixation.

Burke and Dallenbach (3) repeat the experiment with left-handed *O*s. Position is again found to be a determinant of attention, but one that is correlated with manual superiority; for the position to the left of and above the point of fixation has a definite attentional advantage for right-handed *O*s, and the position to the right of and below fixation, for left-handed *O*s.

Dewey and Dallenbach (10), in an experiment performed with the apparatus mentioned, find that the effect of size as a determinant of attention, while cut across and partially obscured by the effect of position, is both definite and positive.

B. *Range of Attention:* The distinction between attributive and cognitive clearness is experimentally established by Dallenbach (5), who finds in a tachistoscopic study that impressions, attributively clear or unclear, may be reported as of various degrees of cognitive clearness. Though attributive clearness and all the conditions which make for it affect cognitive clearness, the latter is influenced also by certain other conditions, so that the two types of clearness do not show an invariable relation. The "subjective" reports—those which had no known physical correlate upon the stimulus card—are considered separately and are separately reported (6). Similar results are obtained; so that the distinction between attributive and cognitive clearness holds for imaginal as well as for sensory experiences.

The results of the experiments also show that, while the impressions of a single consciousness may be of 3 and even 4 or 5 degrees of cognitive clearness, they never are of more than two degrees of attributive clearness. All of the *O*s report, upon the side of attributive clearness, the two-level formation of the attentive consciousness. Dallenbach, examining, in the light of his own results, the three cases of the multi-level type that have been reported in the experimental literature, points out that in two of them the *O*s confuse

cognitive with attributive clearness, and that in the third the *O* gives a temporal account of the clearness variations.

The results further show that the experiments on the "range" of attention, since range has always been determined by the number of objects cognized (*i.e.*, named or reproduced), and since clearness of cognition and clearness of experience are not co-variables, are in reality experiments, not in attention, but in cognition.

The conclusion that the experiments on "range" of attention have been misinterpreted is shared by Fernberger (13). An attempt to apply the principles of the psychophysical method of constant stimuli to the problem of range leads him to suggest that the statistical limen or threshold is a more reliable and more readily determined measure of range than any of the constants previously used. He reports the results of an experiment in which he presents from 4 to 12 foveal stimuli for exposure-times varying between 60 and 100 sigma. The relative frequencies of correct judgment follow a continuous function of ogive form; limens could readily be computed from the data; and the individual limens ranged from 6 to 11 stimulus-objects. Convinced by "a consideration of the introspections . . . that the range of attention is an erroneous title for this sort of experiment," he adopts the term "range of apprehension."

The "range of attention," in which the range was computed on the basis of the number of stimuli cognized, is used by Crosland (4) for comparative purposes as a test in the examination of a case of achromasia.

With Dallenbach's and Fernberger's conclusions in mind regarding the cognitive nature of the experiments on the "range" of attention, Oberly (24) seeks, by adding introspections to the usual tachistoscopic work, "to differentiate the thresholds of attention, cognition, and apprehension." In a preliminary series of experiments, in which from 4 to 15 dots are exposed for 40 sigma by means of a Whipple tachistoscope, Oberly distinguishes three conscious patterns which formed the basis of the *O*'s verbal report: immediate—all the dots were perceived in a single flash of consciousness with an equal and high degree of clearness; grouping—all the dots were seen in a single flash of consciousness, but owing to different degrees of clearness there was an attentional grouping of the stimulus dots; and counting—the report was always made on the basis of some subsequent re-imaging of the stimulus material.

In the main experiments Oberly directs his *O*s, who are 6 in

number and of various degrees of training and experience, to report: "(1) the number of dots which you have apprehended; (2) the degree of assurance or certainty of your judgment [measured on a 5 point scale—1 being a 'guess or do not know' and 5 the certainty of 'a 100 to 1 bet']; (3) the method of determining your report: whether by immediate judgment, grouping of dots, or counting." The judgments, 250 of which are given by every *O* for every value of stimulus, are divided, in the order taken, into 5 groups of 50, and limens are computed for every group and for every pattern "in accordance with the phi-gamma hypothesis," including, "for purposes of calculation, only those reports which were correct and which had an assurance of 5, 4 or 3."

The limens of all the *O*s shows highest with counting, intermediate with grouping, and lowest with immediate judgment; the coefficients of precision (h) are highest with immediate judgment, lower with counting and lowest with grouping. Practice affects all three patterns by way of an increase in the value of the limen.

Because the introspective characterizations—immediate judgment, grouping and counting—do not correspond with the systematic categories that have appearaed in the literature, Oberly transforms them into "attention," "cognition," and "apprehension"; and carries his conclusions directly over from the introspective characterizations to these systematic categories. He justifies the change to attention by Titchener's definition; to cognition, by Dallenbach's study of attributive and cognitive clearness; and to apprehension, by Fernberger's work on the range of apprehension.

Dallenbach (9), in a critical note on Oberly's Study, points out that the transformation of the "immediate" and "grouping" patterns is incorrect in so far as it claims support from Titchener's definition of attention and Dallenbach's experimental work; and that to regard "attention" and "cognition" as levels or degrees of awareness is misleading. Furthermore, in using "for purposes of calculation only those reports which were correct and which had an assurance of 5, 4 or 3," and in classifying the reports "I do not know" with the doubtful judgments, Oberly violates the phi-gamma hypothesis.

C. *Fluctuation of Attention:* After a brief review and criticism of the earlier studies on fluctuation of attention, Gemelli and Galli (15) describe a new method of investigating the problem. The earlier studies are inadequate, because they concern themselves with

only one of the two aspects of the problem: *i.e.*, either with the duration of a specific degree of attention, or with the duration of a specific content of attention; and because the methods employed—the methods of minimal stimuli and of continuous work—do not lead to univocal results.

Stable attention implies not only the maintenance of the content, but that of the degree as well. The fluctuations with minimal stimuli may be explained without recourse to attention. The method of continuous work yields globular results for a period of time, but does not give a measure of any particular moment.

Gemelli and Galli use the method of the complex reaction. Series of visual stimuli (squares with a short line projecting from some one of the 4 cardinal and 4 intermediate points) are presented at a uniform rate of 200 in 30 sec. for intervals of from 2 to 3 min. The subjects react by releasing a telegraph key, in some experiments to one figure, in others to two. Records of the reactions are made by the graphic method. The appearance of the reaction-stimulus was automatically recorded, and the time line by a 200 vs. tuning fork. The subjects were 13 in number, and 25 experiments were performed with every one.

Duration of attention is measured by the length of time that the accuracy and rate of reaction remain constant. Every change of these variables is regarded as a fluctuation of the attention. The results show that the duration of the attention is very brief, on an average of only 1.752 ± 0.357 sec.

In one series, the experiments were continued for 20 min., and the accuracy and average reaction times were computed for every 2.5 sec. interval of that period. The average reaction times become progressively greater, and the number of errors (omissions and false reactions) becomes increasingly larger. These results, however, are not uniform for all the subjects, as the authors are able to distinguish 5 types: (*a*) the waves of attention become gradually longer; (*b*) the waves become longer, but progress is not gradual but step-wise; (*c*) the waves become shorter; (*d*) the waves show the effects of adaptation: better reaction times and fewer errors are made after a brief period of exercise; and (*e*) anomalous types.

When the figures are presented irregularly, the reaction times are noticeably increased in length, but the number of errors remains practically unchanged. In the experiments as a whole the correlation between the length of reaction and the number of errors is 0.91.

In search of a relation between the Traube-Hering waves and the so-called "attention rhythms"—a term which they use without prejudice, as they are not concerned with the ultimate nature of the phenomenon—Griffitts and Gordon (16) take kymographic records of the rhythms of attention, breathing and circulation of nine subjects. The attention rhythms are obtained from visual images, a minimal light, binocular rivalry, and ambiguous perspective figures. A series of experiments with a minimal light, the intensity of which was rhythmically and objectively varied, served as control.

The results show a slight correspondence between the attentional and circulatory rhythms. Visual images and the minimal light tend to appear during the trough and upward slope of the Traube-Hering waves, and to disappear during the crest and downward slope. Since the same tendencies, however, are observed in the control experiments, the authors feel that the conclusion, which has frequently been drawn, that the rate of the attention rhythm is determined by the Traube-Hering rhythm, is not warranted. The results of the control series indicate "that the explanation [of this relationship] is rather to be found in the vasomotor accompaniments of the changes in attention and of the motor responses to those changes."

The breathing and Traube-Hering rhythms synchronize in the case of one subject, but in this case the rate of breathing is only one-third of normal. Furthermore, no correlation is found between the length of the Traube-Hering waves and the attentional rhythms. The latter vary, in general, with the form of the stimulus used. The attention rhythms are longer for the minimal light and visual imagery, and shorter for ambiguous perspective and binocular rivalry.

D. *Measurement of Attention:* McComas' (19) attempt to measure attention was actuated, he tells us, by a practical need in psychiatry and applied psychology. He used the methods of the discriminative reaction. The *O*s were seated before a ground-glass window behind which were four electric bulbs colored respectively red, green, blue and yellow. When the light from one bulb illuminated the window, *O*, who held two fingers of each hand upon reacting keys, immediately pressed the key which turned off that light. The action simultaneously turned on one of the other lights; and when this in turn was extinguished yet another light appeared; and so on for 10 min., which was the duration of the experiment. The right and wrong reactions were automatically registered, and the records were computed separately for the successive 30 sec.

intervals. At first, 5 sec. intervals were taken as the units of the computation, but when they proved too restricted in practice the longer interval was selected. As the arrangement of the colors and the keys was varied, no habitual reaction patterns would be formed. The 11 *O*s were of various degrees of laboratory training, ranging from instructors and graduate students on the one hand to untrained high school pupils on the other. For the purposes of comparison the various intervals of the experiment were scored. The figure obtained by subtracting one-third of the number of wrong reactions from the total number of right reactions was taken as a measure of the performance.

The results of the experiment show: (1) marked individual variations in the speed and accuracy of the reactions; (2) slight practice effects in the records of some of the *O*s; (3) that the times for the continuous discrimination reactions are not comparable with the times obtained in ordinary discriminations; (4) that there is, in the strict sense of the term, no diurnal variation; and (5) that the *O*s are poor judges of their efficiency in this work. The results, however, do not show that attention was responsible for, or in any way correlated with, the variations in the records. The validity of McComas' conclusion, that continuous discrimination reactions may be used as a means for detecting variations in attention, rests upon that point.

Wells, Kelley, and Murphy (29) assume that the degree of attention at any given moment of stimulation is given in the speed with which the reaction takes place. Upon the basis of this assumption and the experimental results of Breitwieser and Woodrow, both of whom found an interval between the warning signal and the signal for reaction within which the reaction is more rapid than within any other pre-stimulus interval, the authors compare the reaction-times for preparatory intervals of approximately 1 and 3 sec. The reaction-stimuli used were lights and sounds, and the reaction-times were measured by Klopsteg's method. The results of 13 out of 15 *O*s were grouped; those of the co-authors, Kelley and Wells, were treated separately. W's results agree with those of the group, which showed a general tendency, in both the light and the sound experiments, in favor of the 3 sec. interval. K's results, however, were anomalous; they showed an equality at the two intervals which was the resultant of favoring the 1 sec. interval for sound, and the 3 sec. interval for light.

The authors conclude that the "differences between the two pre-stimulus intervals represent the height of the attention curves at those times," and that "the quickness with which attention is summoned is thus indicated by the most favored pre-stimulus interval; and the height to which it is summoned, by the comparative speed of the reaction at this period." These conclusions are justified only on the assumption that the reaction-times are affected by attention and by nothing but attention.

3. Relation to Other Phenomena

A. *Intensity:* Newhall (23) takes up the much debated question of intensity and attention. He asks: "what change, if any, in the intensity of sensation, is caused by change in attention?" and he answers his question both historically and experimentally.

Historically, and on the phenomenological side, he finds "a great variety of observation and opinion," which he classifies in a four-fold division accordingly "as the attention has apparently (1) constituted an existential condition for sensation, (2) effected no change, (3) an increase, or (4) a decrease in sensational intensity." On the theoretical side, he finds that six different "causal principles have been advanced in explanation of the observed phenomena: (1) centrifugal reinforcement of sensory impulses, (2) central psychical reinforcement, (3) prominence in consciousness due to inhibition, (4) prominence due to combined facilitation and inhibition, (5) attention as essentially conditioned by motor factors, and (6) the indentity of clearness and consciousness." Newhall merely lists his historical findings; he does not critically analyze or evaluate.

Experimentally, he reports his own investigation. He studied the effect of attention on sound-intensity, using an indirect method of auditory localization "because it seemed easier and surer than the alternative [direct method]." His *O*s were presented with a binaural sound and were asked to report the "change in the location of the phantom when the attention is directed to one component; as compared with its location when the attention is not given a particular direction, or when it is directed to the opposite component."

The stimuli were transmitted telephonically from an electromagnetically driven tuning fork (f) of 100 V. D. to each of *O*'s ears. The relative and absolute intensities of the two stimuli were controlled by variable resistances. In one set of experiments, the *O*s were directed to localize the binaural phantom while under the atten-

tional set conditioned by a preliminary (left or right) uniaural stimulus. Visual fixation was held in the median plane. In a few series, however, the *O*s were allowed to move their eyes naturally to the side to which attention was given. In a second group, the *O*s were asked to "hear out" the right or left component of the binaural sound given at the empirical center and then, under this attentional set, to localize the phantom of a second binaural stimulus. In both groups of experiments the intervals between the stimuli, and the intensities of the stimuli, were varied within narrow limits.

The results of the first group of experiments indicate a biased sensory fatigue-effect which is greatest at the weaker intensities and the shorter time intervals. Long interstimulation intervals and eye-movements tend to counteract the effects of fatigue. The results of the second group of experiments show that the hearing-out and the attentional set which follow it cause a change in the position of the phantom. The attentional set thus aroused persists for some time and has a greater effect upon weak than upon strong intensities.

The results of the experiment as a whole do not bear directly upon the original problem. The experiment shows that there are "five conditions which affect the judgment of position of the binaural phantom when wave-phase and frequency remain constant, *i.e.*, absolute intensity, relative intensity, sensory fatigue, eye-movement, and attention-set"; but, as Newhall himself realizes, it "cannot be said to settle the question of whether attention increases the intensity of the component to which it is directed or decreases the intensity of the component from which it is abstracted." Though Newhall is inclined to the latter conclusion, he has no direct introspective evidence for it.

B. *Affection:* Meenes (**20**), by means of the method of paired comparisons, compares "the effective values of colors attended to with the affective values of the same colors when attended from." Six colors are arranged horizontally in pairs in every possible paired relation, and every pair is compared with every other "(1) with attention upon the right members of each paired stimulus, (2) with attention upon the left member of each paired stimulus, and (3) with attention equally upon both members of each stimulus." Comparisons are made vertically and in both space orders.

Meenes classified his *O*s' preferences according to each color in the preferred pair. His results show that "the preferential orders of the colors are much more widely dispersed for the colors attended

to than for the colors attended from," that "affective judgments are conditioned predominantly upon the colors attended to," and that "colors attended from, but presented with colors attended to, have at most but slight effect upon the judgments."

C. *Interest:* Adams (1) is chiefly concerned in the problem of interest. He attempts to extend Pillsbury's theory of attention so as to make it adequate for the explanation of interest. He begins his study by an examination and comparison of the conditions of attention given by Titchener and Pillsbury, and he arrives at the conclusion that the conditions are "three-fold: physical or objective; physiological or nervous; mental or subjective." By identifying attention with its conditions, and by assuming the functional point of view, he concludes that "attention equals strength of stimulus *minus* amount of nerve energy used up in crossing synapses *plus* amount of activity going on in the receptive region of the cortex." In other words, "attention is essentially a relating activity," "a complex resulting from a combination of the 'push from behind' which initially is sensory, and the 'pull from ahead' which is necessarily central."

From this view of attention Adams approaches the problem of interest. He sets forth the relation of attention to interest in the following seven theses, which he seeks to establish by citing results drawn from experiments in advertising: (1) "Interest results only from the complex form of attention"; (2) "interest results only when the complex form of attention consists of a relatively old and of a relatively new process"; (3) "interest results only when there is a congruence between the incoming and the present contents of consciousness"; (4) "interest has a future reference or implication"; (5) "the interest attaches to the ends, not to the means to the ends"; (6) "interest tends to attach more strongly to the more immediate ends"; (7) "the center of interest is the self." In conclusion, Adams devotes a section to the pedagogical aspects of the problem.

D. *Depersonalization:* Hesnard (18) considers subjective attention in its relations to depersonalization. He rejects Amiel's explanation that depersonalization results from an excessive activity of inner attention, *i.e.*, from a morbid introspective analysis that sets the "I" apart, because he believes, with Dugas, that the disorder, however much it may be affected by inner attention, is at first the cause of inner attention.

After pointing out that care must be taken not to confuse depersonalization with affective and emotional disorders, Hesnard shows that depersonalized subjects do not remain so continually, that the disorder disappears with the fixation of attention,—from which it follows that the relaxation of attention is a primary condition of the derangement. This conclusion does not, however, lead back to the view that the disorder is caused by attention, for he believes the attentive change and the depersonalization are both caused by the relaxation of interest.

The relaxation, however, is more apparent than real. The depersonalized subject continues to be interested, not in the things that surround him, nor even in his own conditions, but in the search after the self to which he is driven by the desire to assert his personality.

In reality, however, there is no such thing as depersonalization, for the subject loses nothing; he is not dissociated, nor is his consciousness divided. He is merely superficially inattentive to reality. Though he is prevented from thinking, responding and acting with all his mental activity—a small part of this being diverted to inner search—he is not prevented completely from doing so.

4. Technological

Dockeray (12) reports the results of two attempts to devise a practical attention-coördination test. In the first attempt, he is concerned with the effect of continuous distraction and of mental work upon the discrimination of slight auditory differences; and in the second, with the effect of mental and physical work upon a complex motor coördination.

In the first attempt four sounders of slightly different pitch and intensity were used as stimuli. These were automatically presented one at a time in irregular order at the rate of one a second for periods of 15 to 20 min. Some one of these four sounds was designated as the reacting stimulus by being given five times in succession. Whenever the sound thus signalled was given thereafter, the subject was to react by pressing an electrical key. In order to regulate the difficulty of discrimination a fifth sounder, the intensity of which could be varied, sounded with each of the other four. Two types of failure were noted: either the subject failed to react, or he reacted to the wrong sound. The experiments were conducted, under normal control conditions and under the distraction of a continuously sounding electrical buzzer or of weak induction shocks, after periods of

rest and after periods of mental work. The results obtained with 6 subjects are equivocal; no constant tendency is observed in their performances. The failure, Dockeray believes, is due to the simplicity of the test; the subjects were able to isolate the task and to make a good record even under unfavorable conditions.

In the second attempt conditions were complicated so as to "demand a broader attention span." Both the stimuli and the reactions were made more complex. Five stimuli, two sounders and three small lights were used. They were presented automatically, in irregular order, at the approximate rates of one every two seconds. The subjects reacted by touching brass plates corresponding to the stimuli. Contact could be made only through a small hole with a metal stylus. If the movement was incorrect or slow a failure was registered, but if it was correct and quickly made a success was registered and a flash of light indicated the success to the subject. Inaccurate adjustments, such as touching the sides of the holes, were recorded as in the steadiness test, and counted as "fumbles." The scores of the subjects were obtained by subtracting a certain per cent of the fumbles from the total number of correct responses. A series of experiments lasted 15 min., and after an hour's rest, or after an hour of mental or physical work, a second series was performed. The results show the same tendency for all 5 subjects: rest periods are followed by improvement; work periods, whether mental or physical, are followed by impairment. These results Dockeray believes, justify the use of the test in "the investigation of the effects of fatigue, low oxygen, ventilation, tobacco and drugs."

Emphasizing the motor aspects of attention, Mudge (**22**) takes as his thesis the statement that "an absolutely quiet school room is the ideal of an unscientific pedagogy." He defends his position by citing numerous examples drawn from his own experience and from the observations of 17 young women in which "automatisms . . . are involved in close attention and study." Such movements may seem irrelevant, but Mudge believes that they have an attention-value, and that "we can best attend when there is a degree of muscular strain." Whence it follows, "that a certain degree of freedom is absolutely essential to the mental . . . welfare of school children."

Devolvé (11) treats of the pedagogical aspects of attention. He opposes those contemporary psychologists who define attention as a state of the mind and who proceed on the basis of that definition to analyze the state and to determine its conditions, because the analysis

into simple processes such as adaptation (Binet), schematization (d'Allonnes), discrimination (Dawes Hicks) dissolves the concept itself. Devolvé would agree with Foucault (14) that attention should be discarded from psychology, if the concept were not of such great value to pedagogy.

Pedagogically, children are said to be attentive when their thoughts are constantly directed to the object of the lesson, and inattentive when their thoughts deviate from this object. The pedagogical problem of attention is solved when the educator obtains the constant connection of the child's associative mechanisms with the desired end. The problem, how these associative connections of the idea of end are established, may be solved in part by examining the methods which teachers employ to sustain the pupils' attention.

The attention-value of lecturing without notes, measured by "the number of ideas correctly remembered" in a modification of the "Aussage" memory method, is found by Moore (21) to vary according to the attitude of the listeners. He gives identical material to two homogeneous groups of college students, reading from lecture notes to one group and speaking from memory to the other, and asks the students to write a detailed account of what they have just heard. In one experiment, in which the students knew that they were being given a test, the scores show no significant difference between the two groups. "When the audience is attending competitively the matter of reading and speaking becomes of small importance." In a second experiment, the test was given as part of the regular lecture; the students did not know, until after the presentation, that they were being tested; and the average number of correct items they reported was 36 per cent greater for spoken utterance than for reading.

Moore concludes from the results of his study that the "speaker who reads his address has to assume an unusual earnestness of purpose in his hearers, a much greater earnestness than normally exists in the class room," and that the teacher who "makes use of notes in the class room . . . is incurring the danger of reducing his real function in the college to the mere marking of class attendance."

Vaërting (28) considers the relation of attention of the higher and lower orders to the problem of native endowment. He distinguishes, among the tests of attention that have been used in the past, two classes: (1) those that are mechanical and are concerned with meaningless activities, such as the Bourdon cancellation test;

and (2) those that introduce a meaningful relation between the stimulus and response. The tests of the second class have a great advantage over those of the first. Both kinds, however, measure attention of the lower order, and this forms only a part of the general ability to concentrate.

In concentration there are two processes: (1) the psychological impulse which stimulates the attention; and (2) the object or activity to which the attention is directed. The psychological impulse may be one of two kinds: will or interest; the resulting attention may accordingly be described as outer or inner. The object or activity of attention may likewise be one of two kinds: mechanical, or mental (thought and imagination); and the attention may accordingly be described as of the lower or higher order. On the basis of this analysis, four kinds of concentration may be distinguished: (1) outer and lower; (2) outer and higher; (3) inner and lower; and (4) inner and higher. The first kind stands at the lowest level; the second and third kinds at an intermediate level; and the fourth kind stands at the highest level.

Attention-tests of the first class mentioned above are concerned only with concentration of the lowest level; test of the second class only with concentration of the lowest and intermediate levels. These levels of concentration have nothing in common with high native endowment, which is related only to the highest level of concentration. It therefore follows that the attention-tests that have thus far been used are inadequate to the investigation of the problems of native endowment.

Sterzinger (26) adapts the Bourdon cancellation test, which in its usual forms tests sensory attention only, to the investigation of abstract attention, the kind of attention that he believes is required of mental workers.

The subjects—school children, 10–11 years old; high school pupils, 18–19 years old; and adults; more than 300 people in all—are given letters arranged in meaningless groups, and are instructed to cancel letters having certain positions; as for example, "cross out every letter between two vowels," "every letter between two consonants," "every letter between two identical letters," "of two identical letters cross out the second." The groups of letters and the instructions are varied so that every letter of the alphabet shall be cancelled. Time is measured by a stop-watch, and the errors are read off by the aid of stencils.

Sterzinger, who is chiefly interested in qualitative results, examines in turn the ways in which the subjects comprehend the instructions, the nature of the work and of the errors, the consciousness of accuracy, and the relation of the results to native endowment. He finds that the instructions were extended (15 ways), confused (3 ways), and inverted (3 ways); that the results were affected by perseveration of earlier cancellations and by certain positions (beginning and end of lines); that omissions are explained by the contraction of the instructions (3 ways), by imperfect attention, and by various special causes; and that good records in the tests depend (1) upon the degree of attention, (2) upon the formation of images corresponding to the instructions, (3) upon the easy reproduction, apprehension and recognition of these images, (4) upon the rapid and fixed arousal of continuous associations, and (5) upon the ease of recollection. Sterzinger's belief, that his test determines whether a person possesses these endowments, is empirically confirmed by the correlations obtained with the teachers' judgments, with range of information, with school work, and with the Bourdon-Whipple test.

Corollary experiments, with two sets of instructions given in turn, were conducted. The temporal relations in which the instructions were given were varied; now one was used first, now the other. The results show that the time and number of errors made under one instruction vary accordingly as it is given first or second. There are not only activities which inhibit subsequent performance, but also activities which facilitate it.

To determine the effect of the number of cancellations, experiments were performed with three forms of 850 letters; the number of letters to be cancelled was 110, 152, and 170 respectively. There were more omissions with the smallest number of cancellations, and the cancellation-time was longer with the greatest number of cancellations.

Hallbauer (17) describes a method and a piece of apparatus designed to test the attention and the reaction-time of motormen. He duplicated, as far as possible, the actual working conditions; the reaction stimuli were presented on an endless band which rolled towards the subject, and the reaction apparatus was copied from the motorman's stand. The rapidity and accuracy of the subject's coördinations were taken as indices of the subject's fitness for the occupation.

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RECENT LITERATURE ON BEHAVIOR IN THE LOWER ORGANISMS

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A. Protozoa

Many of the recent studies on behavior in the protozoa have dealt with the activities of amoeba. Thus Folger (**26**) studied the reactions to light in amoeba. He found that amoeba reacts to sudden increase in illumination by complete cessation of movement, the time required becoming shorter as the intensity increases. The reaction-time was found to be composed of two periods, (a) the stimulation period, during which the amoeba must be exposed to light if there is to be any response, and (b) a latent period, during which exposure is not necessary. Considerable changes in the length of the latent period were observed, "while the stimulation period was found to vary inversely with the intensity of the illumination."

Cannibalism in Amoeba vespertilis is described by Goeffrey Lapage (**43**). These amoebae were frequently observed to ingest but in most cases failed to digest other individuals of their own and also of another species. After subsequent extrusion, many of them disintegrated, but a few recovered their normal activity. The nature of the stimulus causing the adoption of these cannibalistic habits is discussed.

Modification of response in amoeba was observed by Mast and Pusch (**51**). Evidence is presented on the basis of about 30 trials with each of 9 individuals which shows that "when amoeba repeatedly comes in contact with a band of intense light the number of attempts to continue in the original direction decreases as the number of trials increases" and that this indicates some change in amoeba which is "analogous to what is called 'learning' in the higher animals."

The effect of chemicals on locomotion in amoeba is described by J. G. Edwards (**22**). The effect of local application of various

[1] The writer is indebted to Professor S. O. Mast of the Johns Hopkins University, for advice and criticism in the preparation of this review.

acids, hydroxides, salts, alkaloids, nonelectrolytes, KCn, and other chemicals, on the activities of amoeba leads the author to conclude that "the surface of amoeba differs markedly from its interior and from its environment, and that it is this difference that determines the character of the local changes which chemicals induce when applied locally to the surface."

A. M. Schwitalla (**78**) studied the influence of temperature on the rate of locomotion in amoeba. Alternate periods of acceleration and retardation in the rate of locomotion were observed at constant temperatures. The average rate of locomotion was found to increase with a rise in temperature until a maximum is reached at about 25° C., after which it decreases. It is concluded that the temperature apparently affects the rate only through its effect on the rhythmical processes which condition locomotion.

Amoeboid movement is the subject of study by Pantin (**66**), who concludes that marine amoebae of the limax type, may be "looked upon as contracting tubes of gelated ectoplasm, closed at the posterior end, the anterior end being occupied by the fluid ectoplasm of the advancing pseudopodium." He states that the "streaming" begins "within the posterior end of the amoeba" and that the imbibition of water at the anterior end and the syneresis at the posterior end together with the force of the contracting tube of ectoplasm; would cause the endoplasmic stream to be driven forward.

Mast (**46**) however, explains locomotion in Amoeba proteus on the basis of five fundamental factors: (1) Hypertonic solution surrounded by a semipermeable membrane resulting in turgidity. (2) Local swelling of the plasmagel at the tip of the forming or advancing pseudopods with decrease in elasticity. (3) Contraction in the rest of the plasmagel with liguefication on the inner surface at the posterior end resulting in forward flow of the plasmagel. (4) Gelation of the plasmagel at the outer posterior border of the anterior enlargement of the plasmasol forming new granular plasmagel and at the anterior surface of this enlargement forming new hyaline plasmagel. (5) Adhesion of the plasmalemma to the substratum.

Kepner and Reynolds (**39**) record experiments which show that in the Rhizopod, Difflugia, separated pseudopodial fragments are recovered by their cell bodies even when separated by distances up to 1,500 micra. These fragments are not recovered as food but enter at once into the protoplasmic structure of the cell-body. In a later

paper, Reynolds (**76**) shows that Arcella polypora will also reappropriate detached fragments of protoplasm. This occurs only between an individual and a protoplasmic fragment of itself or a closely related specimen. This specificity holds for the progeny of a single individual only from 6 to 22 days, depending upon various factors.

Mast and Gover (**49**) studied the relation between intensity of light and rate of locomotion in Phacus pleuronectes and Euglena gracilis, and its bearing on the problem of orientation. They find that increase in light in certain intensities and with short exposures slightly accelerates locomotion in Euglena and slightly retards it in Phacus. They point out that orientation in these forms cannot be due to the effect on the rate of locomotion of difference in the illumination of the sensitive tissue in different positions in the spiral course of these organisms, as is demanded by the DeCondolle-Verworn theory of orientation as applied to asymmetrical organisms.

Several papers deal with feeding reactions in the protozoa. Goldsmith (**32**) records observations on the feeding of Frontonia on euglenas, diatoms, desmids, and on the filaments of Oscillatoria. Several of the factors involved are described, including the direct pull of the cilia about the mouth, rotation of the body, and the sharp contraction of the body wall. Visscher (**82**) describes the feeding reactions of the ciliate, Dileptus gigas. He found that it discriminates between living organisms and inanimate substances in favor of the former, and selects from among the different kinds of living organisms. He maintains that it captures its prey by means of trichocysts which are of a liquid nature highly toxic with specific cytolytic properties. Selection of food is shown to be dependent on two factors: (a) the physiological state of the organism, and (b) the chemical properties of its trichocysts. Beers (**6**) records observations on the process of feeding in amoeba in which several specimens of frontonia were cut in half by the amoeba. One half of the frontonia was engulfed in a food cup of the amoeba, and as the pseudopodia producing this cup pressed distally against the free half of the frontonia, the halves were "pushed continuously farther apart until the attenuated interconnecting strand is severed and one half of the frontonia is simultaneously engulfed."

O. Glaser (**31**) presents an analysis of the effect of temperature on forward movement in paramecium and a study of this effect in relation to the basic chemical reactions that supply the energy required for the execution of the ciliary beat. He found great indi-

vidual variation, some being " racers and others moving very slowly." The reaction of forward movement, based upon average of a large number of experiments, was found " to vary as an exponential function of the temperature," and a mathematical formula for this function is presented.

In an extensive paper describing many careful observations and experiments on the " geotaxis " of Paramecium, Otto Koehler (40) finds that of the four theories which have been advanced to explain the negative reaction to gravity in paramecium, the pressure and the resistance theories are clearly untenable. He maintains that the same region of the body in all paramecia is the heaviest and that it is impossible that the mechanistic theory should hold for this form. By various experiments, such as feeding finally divided iron filings and testing such individuals with magnetic forces, the author concludes that only the " statocyst theory " is able to explain the facts. He states that the cause of increase in sensitivity is always an increase of the weight of the included body upon the plasma around it, and that the determination of the direction of movement is dependent upon the location of this pressure. He also maintains that the degree of control is dependent upon the CO_2 concentration, that is, upon the strength of the other forces which sensitize the plasma for the perception of certain pressure factors.

B. Porifera

McNair (52) studied the reactions of the fresh water sponge to various stimuli. He found that swift currents of water cause a shortening of the oscular chimney while quiet water results in a cessation of all activities and eventually in death. The edge of the osculum was found to be the most sensitive to stimulation. Cutting the body of the sponge or sticking a needle into it seemed to have no effect except the local effect on the tissues which were injured. Response to stimuli occurs very slowly if at all.

C. Coelenterata

Luminescence in the ctenophore mnemiopsis was studied by A. R. Moore (55). He was able to confirm earlier work that the power of luminescence is suppressed by exposure to bright light. The tactile receptors for causation of luminescence were found to lie only in the rows of paddle plates and to be connected only longitudinally

along these rows. They were found to be entirely independent of the tactile receptors for ciliary and muscular movement which are distributed generally over the surface of the organism and are connected by a nerve net. The same author later (60) studied the mechanism of coördination in the crinoid, Antedon rosaceus. He found that in this form stimulation causes alternating movements which are coördinated but which imply reciprocal inhibition. He also observed that this inhibition was abolished by use of strychnine and nicotine and says that "antedon is negatively stereotropic with reference to its ventral side," while the oral and aboral sides exhibit dynamic symmetry although structurally dissimilar.

An interesting association of a spider-crab and a sea-anemone is described by Thompson (80). It is suggested that the partnership may be regarded as an early stage in the establishment of a true commensalism.

M. M. Moore (61) describes the "tropistic reactions" of the actinean, Cerianthus membranaceus. She concludes that this organism shows "stereotropism," is positively "geotropic," and is positively "phototropic." The reaction time was studied and was found to be composed of a sensitization and a latent period. On the basis of experiments on three animals, a curve is presented which is in accord with the Bunson Roscoe law. In another paper (62) she records the reactions of this coelenterate to two sources of light. Three specimens were again tested with respect to orientation of their free anterior ends. It was found that if the two lights are of equal intensities, the oral disc is extended at right angles to the line connecting the lights, but that with unequal illumination, orientation is not fully in accord with the theory that the effective physical illumination is not the same on the two sides. Various theories are offered to account for this, and mathematical formulae are presented which correlate these findings with those of Garrey, Patten, and others.

D. Echinodermata

Parker (67) finds that the sea urchin, Centrechinus antillarum, is a strongly geonegative animal. He asserts that it climbs up the sides of various objects in light as well as in the dark, and responds not because of light, or of access to oxygen, but clearly in response to gravity. Whether the mechanism of this response is to be found in association with the spines or elsewhere was not ascertained.

Lunar periodicity in reproduction was found by Fox (27) in

his study of the sea urchin Centrechinus (Diadema) sextosus, found in the Red Sea. Simultaneous periods of reproduction were noted for other species, but these were not related to lunar periods. Since oxidation of pigmented animal tissues is shown to be higher in light than in darkness, the author suggests that the light of the moon may be a possible reason for periodic reproduction in Centrechinus.

Dakin and Fordham (19) have demonstrated that in the case of the sea urchin, Echinus esculentus, the eggs give off substances " which actually direct the sperm movements," and that this chemotaxis " is specific for each species." It was impossible to obtain similar results with Toredo, and the authors state that " it is possible that chemotaxis does not occur in all species of Echinoderms, which might explain the negative results of Buller and Loeb."

E. Vermes

The rôle of the nervous system in the locomotion of certain marine polyclads is discussed by Olmsted (65). Four possible types of locomotion are described for several species. The swimming movement is shown to be dependent on the cephalic ganglia, while ciliary action appears to be independent of the nervous system. He holds that ataxic movement is a purely local phenomenon but is controlled by the nervous system and that cutting the nerve cord on one side causes waves to disappear on that side at the level of the cut. The author maintains that locomotion in polyclad worms is comparable in these respects with that of mollusks. A similar study was made by A. R. Moore (59) on the function of the brain in locomotion of the polyclad worm, Yungia aurantiaca. He finds that coördinated swimming movements in Yungia are not dependent upon the presence of the brain, and that after removal of the head, peripheralstimulation does not have its usual effect and finds that the threshold of the nervous mechanism may be lowered by phenol or increased in various iron ratios and peripheral stimulation again throws the mechanism into activity and swimming movements result. The same author (57) records the reactions of Nereis virens to unilateral tension of its musculature. He finds that the anterior segments are oriented reflexly by passive unilateral tension of the posterior musculature, and that the afferent impulses of this reflex arises from any part of the worm and are conducted forward by way of the ventral nerve cord while the efferent impulses flow out from the brain and the anterior two or three ventral ganglia. These

reflexes, he asserts, may be partially or wholly masked by "stereotropism." In another paper (**58**) on orientation to galvanic stimuli in the earthworm, Moore finds by stimulating the animal with a nonpolarizable electrode, and by cutting the nerve cord in various positions, that the entire worm responds to the direction of flow of the current although only a fe wof the ganglia are directly acted upon by the current. He maintains that this would prove that the motor neurones of the same type of function are linked longitudinally and that these connections must be strictly linear. By use of preparations of earthworms in which the cutaneous receptors have been anesthetized with $MgCl_2$ the same author (**56**) was able to initiate peristalsis by means of tension alone. The receptors of the tension reflex are described as intermyal sensory cells of the ventral region of the body wall and are found distributed throughout the entire length of the worm, while the effectors are limited to the anterior 15 or 20 segments. He asserts that the impulse for this reflex is conducted by the ventral nerve cord. The relation of the "reactions of the animal to its own internal tensions" and to various "tropisms" is considered.

Copeland, M., and Wieman, H. L., (**13**) studied the chemical sense and feeding behavior of neries virens. They found that it is carnivorous, but in the absence of other food, it will feed upon sea lettuce, and that it is probably, under natural conditions, an omnivorous animal. They conducted experiments which show that neries depends upon a chemical sense in finding animal food and that sight plays little or no part in the act. Currents in the burrow produced by movements of the body are considered factors in conveying food stimuli to the sense organs. They noted a very interesting reaction, in that if the organism was unable to reach the food by fully extending its body without leaving the burrow, it often reappeared in a new position nearer the source of the stimulating material.

F. Mollusca

The "learning curve" for a snail is reported by Garth (**30**). By the use of a glass T-maze, similar to that used by Yerkes for training an earthworm, and a "strong light as a drive," a snail was trained to pass through the maze without error after 102 trials. The average time for the earlier trials was 857 seconds while that for the last five trials was 316. There is thus evidence of a positive tendency

for the time to decrease with successive trials, and also evidence of "learning of a more or less permanent character."

In the physiological section of an extensive paper on the chromatophores of Limax agrestis, Weber (83) records extensive studies on the reactions of normal and blinded snails to light of various intensities and of different spectral qualities. He found that when exposed to lights of different wave lengths, the color of the organism remains constant, but when exposed to the ultra-violet light a great expansion of the red-brown color occurs, and also that these snails move from the blue light to the red. Oxygen and humidity cause an increase in the red-brown pigment.

In his studies on the attachment of the oyster larvae Nelson (63) finds that when they are ready for attachment, the larva tests out, by means of its foot, a very considerable area before attaching by its left valve, and that while attaching permanently, it holds itself in position by its foot. It is suggested that the circling movements of the larvae while crawling over a substratum serve to produce a "fairly even distribution of the spat."

Copeland (12) finds that locomotion in gastropods of a single genus Polinices (Natica), may be of two types, one dependent on muscular action, the other dependent on ciliary action. It is held that the general ciliary behavior in Polinices strongly upholds the idea that the control of ciliary action has been taken over by the nervous system.

Some observations are recorded by Agersborg (1) on "qualitative chemical and physical stimulation in nudibranchiate molluscs with special reference to the rôle of the rhinophores." He finds that the dorsal tentacles are the most sensitive to tactile stimulation, are also sensitive to acids and to salts, and that the oral tentacles appear to possess a selective function in relation to food. In a second paper (2) the same author describes locomotion in another nudibranchiate mollusc, Dendronotus giganteus. He states that it swims by bending the anterior end of the body sideways to an angle of about 45 degrees, producing each time, a powerful stroke by the head, and forming, in the right or left side of the body wall, a large twisted muscular wave which passes toward the posterior end of the body. By the sweep of these waves, he maintains, rapid locomotion (swimming) is effected, while creeping is effected by direct rhythmic waves augmented by ciliary action of the foot.

B. Grave (33) presents an analysis of the spawning habits and

spawning stimuli of the chiton, Chaetopleura apiculata. Periodicity in the spawning activities of this mollusc was noted for three successive summers. Greatest spawning activity was found to occur at the approach of full moon in each of the three summer months, June, July and August. In the laboratory they were observed to spawn only at night from about 7:30 to 10:30. A change from running to quiet water comparable to tidal changes, and also a change in pressure between high and low tides as well as moonlight, are given as probable factors which determine spawning.

In a paper on the leaping of the stromb, Parker (68) states that locomotion in the conch, Strombus gigas, is accomplished by sudden leaps and not by the slow gliding movement characteristic of most gasteropods. He asserts that in Strombus the foot is extended forward, attached to the substrate by its anterior end and a vigorous muscular contraction follows, whereby the animal's shell is thrown well forward to the extent of half the length of that structure.

A detailed account of the process of feeding in the Lamellibranch, Mya, is given by Yonge (87). Exception is taken to the views of Kellogg regarding this process. The selection and rejection of particles on the surface of the palps is explained by the differential action of the various ciliary currents on these surfaces.

In a study of the life history and growth of the Pismo-clam, Weymouth (85) presents a careful study of the habits and behavior of this clam, both in its adult and larval stages.

A unique habit is described for the cuttlefish, Idiosepius pygmaeus by Madoka Sasahi (77). These small cephalopods attach themselves to the under surface of Ulva fronds, from which vantage point they seem to watch for their prey. The adhesive organ is a roughened area on the back, which contains specialized cells, many of which are glandular and apparently produce the adhesive substance.

G. Crustacea

Chessman (9) finds that the eyes of the land crab, Cardisoma armatum, function only ineffectively in daylight, during which time the crab relies almost entirely on the abundant sensitive setae. He states that they do not respond to sound but that the sense of taste and smell are well developed. These sense organs are described as being " inside the mouth," while the tactile setae were found scattered over the limbs.

In a study of certain land isopods (Oniscus and others) Hart-

line (**36**) tested their negative reactions to light, over a large range of intensities, especially low ones. Below an intensity of 0.0026 meter candles, he found that the amount of angular deflection becomes less and less, in proportion to the logarithm of the intensity, until at 0.00003 m.c., the movements are the same as in darkness. In this he sees a clear correlation with Hecht's work, on Mya. The author maintains that these results support Loeb's theory that "phototropism" is the result of a difference in tonic contraction of opposing muscles, determined in a purely photochemical way by the excess of decomposed photosensitive substance in one photoreceptor.

Crozier and Snyder (**18**) found selective mating in a study of 61 pairs of Gammarus locusta and 71 pairs of Dikero gammarus faciatus. Each individual was measured and the results are plotted in graphs which clearly indicate assortative mating. The authors advance the opinion that graded correlation between the sizes of members of conjugating pairs is determined by mechanical factors of the clasping process.

In his extensive studies on the "Comparative Physiology of Digestion, II," Yonge (**88**) describes the feeding habits of the Norway lobster, Nephrops norwegicus, in connection with studies of the process of digestion and assimilation in this crustacean.

In a paper entitled "Circus Movements of Limulus and the Tropism Theory" Cole (**10**) records experiments on the reactions to light of young specimens of the king-crab under laboratory conditions. They were found to react positively to light and to execute circus movements when the median and the opposite lateral eyes were removed or covered. From the experimental data it was calculated that the diameter of the circle in circus movements varies inversely with the light intensity, while the rate of locomotion varies directly with the light intensity. The author holds that the evidence presented is "one more link in the chain of evidence" in favor of "Loeb's theory of tropism formulated in 1888," and "is contrary to Mast's (1922) most recent theory that orientation is regulated by localized stimulation." In a later paper the same author (**11**) states that "laboratory age" has a pronounced effect on the reactions to light in young specimens of Limulus. More than 60 per cent of freshly collected specimens were observed to be positive, but within 48 hours less than 30 per cent were positive, with a corresponding increase in those negative to light up to 55 per cent. At the expiration of 100 hours in the laboratory only about 28 per cent were found

to be positive, and a similar percentage negative while almost half of them (44 per cent) were indifferent. No explanation of these changes is offered.

The reactions of Daphnia to light were tested by F. Alverdes (**3**) by placing the organisms in glass tubes which were inserted in various ways and at various angles in paper tubes, and also in glass aquaria. He maintains that the back-and-forth swimming of the organism is a " flight reaction " and is due to the constantly changing " optimum for light within each organism." He states also, that for the completion of any orientation Daphnia is not dependent upon adequate environment alone, but also upon suitable " disposition and mood." He maintains that both these factors must be controlled if the desired results are to be obtained, and that as both are variable, changing from time to time, the behavior is ultimately dependent upon both " environment and circumstance."

An interesting and careful account of the moulting of the lobster is given by R. Elmhurst (**23**).

Color vision in Daphnia magna was studied by O. Koehler (**41**), who finds that adaptation of these organisms to light of different intensities modifies their reaction. If adapted to a medium light intensity, they were able to distinguish light of long wave length, from light of short wave length and either from colorless white light (farblos weissen Lichte). Dark adapted specimens were found to be negative to light but were totally color blind. They were, however, sensitive to colors when adapted to a medium amount of light. When adapted to bright light, they were clearly " positively phototropic," but again were color blind. He concludes by showing that they react to light in a manner very comparable to man.

Erhard (**25**) tested the reaction of Cyclops, Chydrons and Diaptomus to light, and found that they are normally positive, but this reaction depended upon adaptation. The sensitiveness to change in brightness as well as distinction of the threshold was found to be about the same as for man. Accordingly, it is held that these reactions are in accord with the Weber law. He also found that these organisms are sensitive to ultraviolet light, but are not sensitive to spectral colors.

The reactions of the larvae of the shrimp, and of the squid, to monochromatic light were studied by G. M. White (**86**). The author finds that for both types of larvae, the maximum stimulation is obtained by light in the blue-green field of the spectrum (470–

510 $\mu\mu$), while yellow-green and yellow-blue are less stimulating. All of the above are relatively more stimulating for the squid than for the shrimp larvae, while the rays beyond 620 $\mu\mu$, do not affect the squid larvae while the shrimp are stimulated by them.

H. Insects

Wheeler (84) records some interesting observations on Gigantrops destructor and other leaping ants. A discussion of this peculiar habit in several forms is associated with notes on the systematic relations of these ants.

Kopec (42) studied the influence of inanition on the development and the duration of life in insects. He finds that intermittent starvation prolongs the larval life but has no influence on the duration of life of the imago. Evidence of adaptation to abnormal conditions is presented, but no evidence of inheritance of such modifiability was found.

Crozier and Moore (17) describe a "homostrophic reflex" and "stereotropism" in diplopods. They find that in the orientation of certain diplopods "passive unilateral tension involves the homostrophic reflex"—"a reflex orientation of the head segments in response to bending of the posterior part of the body and mediated by a definite muscular mechanism." They find also that under some conditions, "stereotropism" in these forms may mask the "homostrophic reflex." For when the organism is in contact with two lateral surfaces of equal extent, the path upon emergence is straight, conforming to the law of parallelogram of forces. The senior author (15) reports similar studies on "stereotropism in Tenebrio larvae." Orientation in these forms was induced through lateral contact with a surface. Observations were made in a dark room under red light of very low intensity. The author concludes that "stereotropism is truly of a tropistic character." In another paper (14) this author studied locomotion in the larvae of the slug-moths (Cochlidiidae). They were found to creep by means of waves of muscular activity, which run from the posterior to the anterior end of the flattened adhesive ventral surface. Similarities are pointed out between locomotion in these organisms and in actinians, platyhelminthes, chitons, and gasteropods.

Minnich (54) has made a quantitative study of tarsal sensitivity to solutions of saccharose in the red admiral butterfly (Pyrameis atalanta Linn). The threshold of response to sugar solutions was found to vary directly with the nutritional condition of the organism

and it was found that the tarsal sensitivity of this organism may be as much as 256 times that of the human tongue. It is suggested that this high degree of sensitivity to saccharose is correlated with the fact that sugars form the chief food of this insect. In a second paper (53) the author records experiments on the chemical sensitivity of the tarsi of the same butterfly. He finds that its four ambulatory tarsi possess contact chemoreceptors and that it is able to distinguish different substances by means of these receptors. Appropriate stimulation was found to produce an extension of the proboscis, and responses to certain types of stimulation were found to be conditioned upon the nutritional condition of the animal. The author maintains that these receptors may appropriately be termed organs of taste.

Baldi (5) has studied the circus movements in Coleoptera. He found that in some genera these movements may be caused by injury to the supra-oesophageal ganglia, and that they are usually due to a higher degree of flexion in all of the joints of the legs on the side of the organism opposed to that of the cerebral wound, than in those on the same side.

The process of founding new colonies by the ant, Acanthomyops fuliginosus, is described by Donisthorpe (21). Abundant evidence is cited to show that the queens of this species are unable to rear their brood unaided, and must rejoin the parent colony, or a detachment of workers of her own species, or else must seek out a colony of Lasius umbratus and have her own young reared by the workers of this ant, whose own queen must either be killed or eventually die, leaving a pure and thriving colony of Acanthomyops fuliginosus.

Plath has studied the behavior of several species of bumblebees. In one paper (70), he describes a unique method of defense of Bremus fervidus, in which the bees cover an enemy with honey in an attempt to expel the intruder. In another paper (71) he describes the nesting habits of eight species of North American bumblebees, with special reference to their habits of building subterranean nests. Another paper (73) deals largely with the nesting habits of confined Bremus queens. In a paper entitled Observations on the so-called "trumpeter" in bumblebee colonies (74), the author finds that the "trumpeter" functions in ventilating the hive, and has nothing to do with rousing the colony, as has been previously maintained by many workers, as cited in the interesting review of literature. Notes on the Egg-eating Habit of Bumblebees is the title of another article (75), and an account of the life-history and habits,

especially of the queens of the parasitic members of the genus Psithyrus is given in another article (72), containing many interesting notes on the relations between the parasite and host.

Turner (81) reports a study of the behavior of the mining Eumenid, Odynerus dorsalis. Details of the nesting habit and its colonial features are given. Food gathering and storing are described and experiments on the relation of landmarks to orientation convince the author that they are used in the finding of their own nests.

Frisch (28) finds that bees are able to secure the aid of their fellows in obtaining a new supply of food, by means of certain characteristic activities, a kind of dancing, which allows their fellows to understand the situation and follow the leader, largely by scent. Or they may be able to find the flower or other source from which the new supply of food came, by recognizing the specific odor of the pollen or nectar carried by the scout.

An analysis of insect environments and responses is attempted by C. H. T. Townsend (79) who maintains that the former consists of only three classes of elements: Media, Factors, and Controls. Each of these are subdivided into various divisions, but as the Media and Controls are constants, only the Factors need be measured in any given analysis, and also that tropisms are to be classified with reference to the factors to which they constitute responses.

The stimulating efficiency of intermittent light is found by Dolley (20) often to be greater than that of continuous illumination. In his experiments on the tachina-fly, he found that at flash frequencies of from 15 to 50 per second it is higher, at a frequency of 2 per second it is lower, than that for continuous illumination, while at 5, 60, and 160 per second it is approximately equal to that of continuous illumination.

Crozier, W. J., and Frederighi, H. (16) in a paper entitled "The Phototropic Mechanism in Ranatra," maintain that definite proof was obtained that in the orientation of this water-scorpion to light, the relative postures of the appendages, resulting in a bilateral difference of effective stroke in swimming, is the mechanism of orientation, and that the frequency of locomotor movements is the same on the two sides of the body.

The process of photic orientation in the robber-fly, Proctacanthus philadelphicus is the title of a paper by Mast (48). He finds, (1) that specimens orient fairly well when the front and the middle legs on one side have been removed, indicating that orientation is

not necessarily dependent upon balanced or antagonistic actions in the locomotor appendages on opposite sides of the organism; (2) that specimens with one eye covered usually lean toward the functional eye, but that they lean much more when on a white than when on a black background, indicating that leaning is largely due to illumination of the ventral surface of the eye; (3) that leaning and turning are not necessarily causally related; (4) that when insects are oriented under natural conditions the two eyes are rarely if ever equally illuminated and (5) that in light from two or more sources which differ in intensity but are equal in other respects, the two eyes do not receive the same amount of light energy when the insects are oriented.

The effect of luminous intensity on the relation between stimulating efficiency and flash frequency of intermittent light in the Drone-fly, Eristalis tenax, was studied by Mast and Dolley (**50**). The organisms were exposed in a dark room to well defined beams of light which were interposed by a rotating sectored disc. This disc was revolved at various known revolutions per minute—up to 125 per second. The authors conclude that "the stimulating efficiency of intermittent light in the orientation of Eristalis varies with the flash-frequency; that in intermittent light the flash-frequency for maximum stimulating efficiency is higher in strong light than in weak light; and that the maximum stimulating efficiency of intermittent light in relation to that of continuous light decreases as the luminous intensity decreases; and finally, that these facts support the contention that there are in the photoreceptors or the nervous system of insects, alternate sensitive and refractory periods and that continuous illumination does not act continuously in photic stimulation.

Mast (**47**) in an extensive paper on the photic orientation in insects gives a thorough review of the recent theories of orientation, includes a description of much original work, and adds an extensive discussion. He finds that orientation may occur while on the wing by turning up or down while both eyes are continuously and equally illuminated, and that when insects are oriented in light from two sources, the two eyes are not equally illuminated except when the two sources of illumination are equal in size, intensity, and distance from the insect. He finds orientation in insects with one eye covered in which case both eyes are never equally illuminated, and also when the legs on one side are removed, in which case balanced action in locomotor appendages is impossible. He presents many other facts

in opposition to the balanced action, tonus, or Ray-Verworm theories. The author maintains that stimulation of different regions of the retina in either eye alone sets up in the legs on both sides coördinated reflexes of such a nature that they tend to direct the organism toward the source of stimulation, and that orientation is brought about by a series of differential responses to localized stimulation, which in photic orientation depend upon the localization of the stimulus in the eye. Regarding the nature of the stimulus Mast maintains that there are two classes: one in which the processes are periodic and reversible and one in which they are continuous and irreversible. He maintains that a great majority of reactions in light belong to the periodic class, but that there are some which appear to belong to the second class, in which there is no perceptible threshold, in which the amount of stimulating energy necessary to initiate a response is very small and in which the response appears to be irreversible, and whose magnitude is probably specifically related to the stimulating agent. Regarding the Bunsen-Roscoe law, the author maintains that it holds in certain respects for all reactions provided the time factor is sufficiently short and that it holds approximately, within certain limits of variation in intensity in reference to the amount of energy required to initiate reactions (threshold), but that it does not hold for any reactions in reference to the relation between the stimulating energy and the magnitude of the reaction. The author's final conclusion is that the tonus hypothesis, or any other that demands balanced action in receptors and locomotor appendages on opposite sides, does not fully account for orientation in insects, and that orientation in these organisms is dependent upon series of coördinated reflexes in the legs on both sides, specifically related to the localization of the stimulus in either eye and inhibition of the effect of illumination in one eye by simultaneous illumination in the other.

I. Miscellaneous Papers

Buddenbrock (**8**) studied the reactions to light of a large number of animals belonging to many phyla. Camera drawings are given for many of the responses when an organism was exposed to two lights of equal intensities. He finds that while some of them move to a middle point in accord with the "Tropism-theory" very many of them react only to one light, quite independent of the other. He also finds a third group, containing forms like the star-fish, which he is unable to class in either of the two groups, and a few of the

organisms tested (as Carcinus) react as if functionally single-eyed instead of in accord with their bilateral structure. The author concludes that the "tropism-theory" holds, if at all, for only a limited number of organisms.

In a study of the Growth of Marine Animals on Submerged Metals, G. H. Parker (69) submerged metal panels of various kinds during the summer months. These were placed in the water, both singly and in couples. His observations lead to the conclusion that marine animals will grow upon any heavy metal, provided that metal does not liberate ions or soluble compounds.

Interesting observations on the feeding habits of various marine organisms are recorded by M. V. Lebour (44) in a paper on "Fish-eating Plankton Organisms." The forms studied include Aurelia, Medusoids, Pleurobrachia, Sagitta, and Tomopteris. She finds that "a certain amount of selection is apparent for the tentacles often reject food." Thus it was noted that medusae "preferred" fish to small crustaceans, and also that members of any given species did not as a rule eat each other, although eating large numbers of individuals of other species.

The behavior of various aquatic organisms including larval Ephemeridae, Corethra larvae, Cyclops, Daphnia, Ostracods, water-mites, Asellus and Chironomidea larvae, was studied by F. Alverdes (4). By the use of a binocular with a "water lens," he observed their reactions to food, to a needle, to light, and to other organisms. He found that many of them show "signal reactions" with their antennae and that they "flee" from certain organisms and not from others. He was unable to ascertain if they were able to "see" a needle or if the reaction was caused by a disturbance in the water, but he believes the former was the case. He found that some were much more sensitive to touch than others, and noted a distinct difference in "temperament" between individuals of the same species. He noted abundant evidences of memory and found that the last experience was retained most clearly.

Grave and McCosh (34) find that the tadpole-like larvae of the tunicate, Perophora viridis, shows first a positive and later a negative reaction of light, depending upon the time after liberation. Specific reaction to gravity was also observed, and the total length of the free-swimming period is recorded for many individuals. An analysis is also given of the physioligical and structural adaptations of the larvae to the particular conditions of the habitat of the species.

In a study of the free-swimming larvae of the tunicate, Botryllus Schlosseri, Grave and Woodbridge (**35**) find that, in agreement with many marine forms, these larvae are positive to light and negative to gravity, when first liberated. The free swimming period averages about two hours, and by the end of this period the organisms are negative to light and positive to gravity. An interesting feature of the study was the ascertainment of a reaction to a shadow, which the authors maintain " is an effective and important link in the chain of responses " which are " nicely adjusted and coördinated to produce effects of survival value to the species."

Hess, C. von, (**38**) studied the difference in sensitivity for brightness of illumination (Unterschiedsempfindlichkeit für Helligkeiten). He found that for all invertebrates having eyes, down to the Eichinoderms, it is the same or very similar to man. He also found that for invertebrates, taken collectively, the spectrum in the region of yellow-green to green, is definitely the brightest, and that the region of the ultra violet (400–300 $\mu\mu$) is relatively much brighter for the Arthropods than for man. Correlating this work with his studies on the color of plants and animals, he argues that the explanation of these phenomena must be found in entirely different directions than heretofore attempted.

J. General Papers

Several papers have appeared which will serve to indicate the trend of the work within the last few years. Thus Manquat (**45**) gives a very excellent review: " la Théorie des Tropismes dans le comportement animal." He postulates a biological determinism (déterminisme biologique) which directs the activities of the organism. Thus he states " Nul animal, en effet, ne saurait agir que *déterminé* mais tandis que Loeb et son Ecole ne veulent voir que le déterminisme que l'actionne *en dehors* de son individualité nous prétendons que le déterminisme se trouve *au dedans*." It is evident that this author believes that the fundamental error in all existing theories of " tropism " is their emphasis on external factors, while he maintains that the determining factor is *within* each organism.

Northrop and Loeb (**64**) discuss the photochemical basis of " animal heliotropism." They conclude that animals are oriented by light in such a way that the product of light intensity times the duration of illumination, multiplied by the cosine of the angle of incidence of the light at the surface element of the photosensitive organs,

is the same for symmetrical photosensitive elements of the eyes on the skin.

" Kritik von J. Loeb's Tropismenlehre " is the title of an extensive paper by H. Erhard (24), in which the author carefully reviews the entire field of " tropism-theories," with special reference to those advanced by Loeb. The author quotes at length from Loeb's work as well as from others and gives abundant references to original articles. He acknowledges that there are many reactions which clearly follow known laws of physics and chemistry, but maintains that there are others which are clearly " instinctive," and finally a third class which arise from " free-will " action. Between these three classes of reactions there are, according to this author, only gradual but no fundamental differences. He states that our knowledge to-day allows us to comprehend but not to explain the life process in terms of laws. Finally he states that such interpretations depend upon one's point of view (" Ce que l'ae vu "). He holds finally, that for an explanation (Erklärung) Loeb's theory does not suffice, for one must first define the terms, and consequently there " is no Tropism theory, but only the one word, Tropism."

C. v. Hess (37) in an extensive paper entitled " Farbenlehre," gives a review of the development of color physiology during the last 20 years. His bibliography lists 194 titles. He reviews the literature on color-blindness, on various theories regarding light perception and devotes 38 pages to " comparative color-learning in animals." He maintains that the idea of " purely reflex automatons " is no longer applied, even by the most extreme exponents of this theory, to the higher forms at least, and maintains that conclusive evidence is still lacking to make this fit the activities of any animal.

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DISCUSSION

I wish to take exception to some of the statements made in the November issue of the BULLETIN by Professor H. B. English in his review of my essay entitled *Der Intellektuelle Eigenwert der Gefühlsbetonung,* inasmuch as his statement of its contents does not agree with the view I meant to express.[1]

A. *Elementary Feelings.* (The feeling tones of elementary sense-impressions.) I. I cannot recognize as mine the opinion mentioned in the review that "the plasure or unpleasure which is ordinarily said to 'accompany' a sense impression is merely the pleasure-unpleasure aspect of an unlocalized provoked or secondary reaction." That which is "*ordinarily*" said to *accompany* a sense impression comprises, I believe, also—and in the first place—the inherent pleasure or unpleasure of the sense-impression itself. And, *strictly* speaking, the pleasure or unpleasure of a simple sense impression is, I think, in itself nothing but this very impression itself as unaccompanied by any localizing or explaining presentations and as unattended by any impressions deriving from secondary reactions (*cf.* my essay, pp. 75 ff.).

I am therefore very far from identifying "feeling-tone" in *general* "with an internal sensory response." And my exposition—though accentuating the usefulness, but also the insufficiency, of the James-Lange hypothesis for the psychology of the feeling-tone of *emotions*—does not at all "accord with the visceral sensation theory" as regards *elementary* feelings (*cf.* my essay, p. 88). The unpleasure of a puncture is, in itself, identical with the puncture sensation; no matter how many secondary experiences (which may, in their turn, be conceived as feelings or sensations according as one succeeds in "objectifying" them by localizing them and giving them a physiological explanation) may make it company and hide its real nature. The pleasure of a simple color sensation has, in itself, nothing to do with the impressions occasioned by the acts of consciousness associatively provoked or with the impressions deriving from its motor and organic reactions. Impossible as it is, even in thought, completely to isolate the first impression, an attempt at so doing is necessary if one desires to test the probability of the identity in question.

[1] Cf. *Scandinavian Sci. Rev.*, Vol. 2, pp. 223.

II. Consequently I do not think that "the variability in the hedonic tone is due to the difference in this secondary reaction caused by a slight difference in the primary reaction, some unnoticed attendant circumstance which evokes a quite different organic resonance." In my belief, the hedonic tone is, in itself (*i.e.* as undisturbed by any secondary impressions) of the same infinite variability as the sense-impressions with which it is ordinarily said to be "intimately connected" (*cf.* my essay, p. 75). And the division of all feeling-tones into pleasure and unpleasure has hardly any other justification than its practical usefulness as distinguishing the impressions implying a momentary heightening of life's value from those of the contrary effect (*cf.* my essay, p. 80).

III. I do not think it right to say that organic and visceral reactions are "notoriously lacking in objectivity," if it is to be understood as notoriously quite inaccessible to objectification. I suppose it correcter to say that the objectification of a majority of visceral reactions offers much greater difficulties than that of a majority of other sense impressions, and that the former impressions are therefore more apt than the latter to present themselves as "feelings" only.

IV. I do not see why the real identity of elementary sensation and elementary feeling should "break down" by supposing their differentiation to depend on the being or not-being objectified. As far as I can see, a thing or its representative in consciousness does not necessarily lose its inherent qualities (its "identity with itself") by being seen in different lights. As a set of lines may be seen as a set of lines only or as the outlines of a definite object without necessarily changing its forms or dimensions; as a tone may be heard as a tone only or as a cry without necessarily changing its pitch or timbre, its strength or duration, so with any other sense-impression or set of sense-impressions and its reproductions. If, however, a change takes place, the experience will, on closer examination, prove changed as sensation and as feeling alike.

Nor do I, therefore, see that "what we have (if elementary sensation is elementary feeling as accompanied by objectifying factors) is the assertion of two factors present in all experience, more especially in all sensory experience; the bare presentation or sentience or affection of the self and the objectifying factors." What, under the said supposition, we have is from the point of view here in question, the assertion of two possible modes of appearance for all acts

of consciousness capable of being objectified—the objectifying factors themselves included the intellectual value of any act of consciousness does not, however, in the least depend on the possibility of its objectification (*cf.* my essay, p. 76).

B. *The Higher Feelings.* (The feeling-tones of moods and emotions.) I do not agree that the higher feelings are in my book said to constitute a separate sort of conscious formations "which really do contrast with the formations which are properly called 'intellectual.'" There are, it seems to me, good reasons for speaking of a more or less palpable contrast between the feeling-tone of higher feelings and *other departments of intellect.* There are, from a certain point of view, good reasons for considering as two more or less distinct groups of conscious formations, the comparatively "affective" (generally conveying a relatively strong consciousness of "self" in its immediate and unanalyzed totality and relatively strong spontaneous visceral and motor reactions) and the comparatively "unaffective." But both groups are, as raw materials and as more or less worked elements of consciousness, equally intellectual, equally indispensable for "understanding" the world, human life and struggles not to forget (*cf.* my essay, p. 91). According to Mr. English "the two ways in which intellect manifests itself" are nowhere developed in my essay. In my opinion that is done explicitly, though briefly, in the second chapter, implicitly more or less throughout the book.

Most readers may perhaps—with Mr. English—find somewhat of a self-contradiction in my essay's giving so much space to the discussion of the principal objections against the James-Lange hypothesis,[2] while at the same time it declares the intellectual value of all feeling-tones independent of any definite hypothesis with regards to their mechanism. My reason for paying so much attention to the James-Lange theory was my belief that this theory is of much greater value than of late generally admitted and, though of course not perfect, particularly adapted to meet one of the arguments most likely to be raised against all attacks on the affective-intellectual

[2] In a separate chapter I have tried to weigh the most interesting arguments against the James-Lange theory known to me (those contained in STUMPF's article in *Zeit. f. Psychol. u. Physiol. d. Sinnesorgane,* 1899; A. LEHMANN's *Hauptgesetze des menschlichen Gefühlslebens,* 2 Aufl. 1914; TH. ZIEHEN's *Grundlagen der Psychologie,* 1915, and EBBINGHAUS' *Grundzüge der Psychologie,* 4 Aufl. 1919.

dualism, namely: that if the feeling-tones of emotions are to be considered as intellectual formations of consciousness, they ought not to be absolutely inferior to all elements of consciousness already acknowledged intellectual as to the possibility of more or less plausibly explaining their psychophysical mechanism. As for the *elementary* feeling-tones, their mechanism demands no separate explanation at all if, as in my essay maintained, elementary feeling and elementary sensation are the same thing in different modes of appearance.

In itself, however, it is, I think, quite irrelevant as to the justification of subordinating an element of consciousness to intellect whether any plausible explanation of its mechanism has already been found or not. The visual impressions and their reproductions were, in reality if not in appearance, just as intellectual before any explanation of their mechanism had been given as they are now. The sensations of bodily fatigue, of hunger and thirst and their reproductions are evidently, in spite of the relative obscurity of their mechanism, just as necessary for understanding human desires and activities as any other sensation for understanding any other thing. And the highly complicated sensations characteristic of the different emotions likewise.

T. PARR.

Bergen, Norway.

REJOINDER TO PROFESSOR PARR

The progress of psychology is little advanced by criticism, reply and rejoinder. I am therefore content to have Professor Parr restate his position in reply to my criticisms—necessarily very brief—and let the matter rest. I am much concerned, however, with the question as to the accuracy with which I have reported the positions set forth in the book under review.

After reading Professor Parr's paper I find but one point on which I seem to have misrepresented him. I gathered, and still read his book as implying, that the feeling tone of the secondary (organic) response is the chief constituent of our feelings as these are ordinarily experienced. (Naturally in this there is no reference to "elementary" feelings which I would scarcely have referred to as "fusions.") This is not in the least inconsistent with Parr's general thesis of the identity of feeling and sensation and in my opinion is necessary to the plausibility of that thesis.

For the problem seems to me otherwise insoluble: how can two sensations, which are as nearly identical as two temporally distinct experiences can be, have contradictory feeling attributes if the feeling is identical with the sensation? To say that a sensation may have many feeling varieties is not to the point; I should be inclined to agree. But how can it be identical, in a non-Hegelian world, with opposites?

My bias toward interpreting Professor Parr's book in a way which would appear plausible has evidently led me into overstressing certain passages which seem to take the position which I—wrongly, he now tells us—ascribed to him. And it is clear that this interpretation has colored my whole treatment in details to some extent. Yet I still feel that I have presented an abstract of his essay which fairly represents his views.

HORACE B. ENGLISH.

Wesleyan University.

DRESSER, H. W., *Psychology in Theory and Application.* N. Y.: Crowell, 1924. Pp. xviii+727.

The author states in the preface that the book has been written "to meet the kind of need which arises in science when knowledge increases so rapidly that systematic thought can hardly keep pace with it," and the purpose therefore is "to coördinate the various divisions and applications of psychology so far as they belong under the head of science." The author's aim is commendable, since good systematic thought and coördination are of decided value—but let us turn to the end of the book for the concluding remarks. The last page is given over to a discussion of the transfiguration of patriotism, prohibition, love, God, and the Great Society; and these topics suggest the kind of material which intervenes between the scientific point of departure in the preface and the general conclusion. The following quotation from the end of the book would have been quite suitable in the preface: "We need never stop where mere naturalism ends; psychology is no more able to disprove consciousness with its higher values than the successive materialisms which have tried, since the dawn of atomism in ancient Greece, to prove that thought is a product of the brain. . . . The work of philosophy may still prove to be the highest which the human mind can achieve. But no contribution is likely to come from psychology in this direction till psychologists overcome the habit of keeping so close to the ground, devoting nearly all the time to studying the beginnings of mental life, and leaving scarcely an hour for our higher nature before their lectures come to an end" (pp. 710–711). Considerable attention is given to these "higher values," and the author acknowledges an obvious indebtedness to his teachers, Royce and James. Among recent works, McDougall's *Outline of Psychology,* furnishes a "unifying clue" which is closely followed.

As one passes from the first to the last of the 43 chapters there is a gradual transition from the field of science to the realm of the "higher values." The work of Titchener on the systematization of psychology is summarily dismissed at the beginning of the book. Behaviorism is criticized. The physiological foundations of human

activity are ignored. The scientific method is found wanting. *Purpose* furnishes the main solution, as shown by the sentence which follows. "This conception ('purpose') will give us a view of the instincts as springs of energy (McDougall), a view of the behavior of the natural man; and a theory of the whole field of mental life with its various elements and phases, including attention and interest, imagination, temperament, character, intellect, will; as well as a basis for social psychology, and an opportunity for reconstructing the data of mental life" (p. 17).

The subject-matter of the book falls into five main divisions. The first part deals with "General Psychology" (156 pp.), and is based on several textbooks. Here we find a general discussion of the views of some well-known writers, with full critical notes for all who have a behavioristic or scientific attitude. The author's manner of developing the various topics is about as follows: "Mr. A takes this position. B has a different view. C fails to recognize the philosophical origin of this theory. D thinks there is something in behaviorism. C ignores the spiritual side. Therefore,—we agree with McDougall." Many of the older psychological terms are used, and only a brief mention is made of experimental work. The contributions of William James help to make a place for the spiritual side of man.

Part 2 deals with abnormal psychology (92 pp.), and it is given the ambiguous heading "Psychology of the Hidden Self." There are chapters on suggestion, psychotherapy, psychoanalysis, sleep and dreams, etc. The reader is informed that the "Study of the instincts affords a direct approach to the investigation of the abnormal" (p. 157). The claims for psychical research are then presented. Man is limited by the "states" which succeed one another above the threshold of consciousness, and F. W. H. Myers is justified in his spiritualistic interpretation of the unconscious. In contrast with the "assumed extra-psychical world," F. W. H. Myers would explain everything as far as possible in terms of what goes on "within the self." Myers' conception affords "a unifying basis for an investigation of the entire field whose content remains to be determined" (p. 168). Dr. Dresser does not believe that Freud has radically altered our views on human nature.

Part 3 is concerned with "Vocational and Industrial Psychology" (132 pp.), and the problem of human engineering in business is discussed in a general way. Although the subject-matter is clearly

behavioristic, the author raises further objections to this form of psychology. To preserve the higher values in business, it is necessary to postulate an instinct of constructiveness which is in every way "as genuine and irresistible in man as in the bee or the beaver" (p. 334).

Part 4 is given over to a discussion of "Social Psychology" (176 pp.), and the treatment coincides very well with the well-known views of McDougall. A very remarkable interpretation is placed on some of Professor Dewey's writings. The author is primarily interested in showing that instinct rather than habit should be the central principle in social psychology. "To stop with habits is to stop with the conditional reflexes of behaviorism, hence to minimize intelligence. It leaves us with guesses as to how some of our most important habits are formed, and without any way to account for the drive which gives them persistence and makes our experience directive: habits are instruments which serve our purposes, but do not determine them" (p. 390). There is further discussion of The Great Society. Dr. Dresser is obviously not interested in developnemtal psychology: what we learn and when we learn it is considered to be of minor importance.

The fifth and last part of the book has to do with "Social Organization" (158 pp.), and is somewhat sociological in nature. In the general task of securing systematic thought and coördination the author leaves the psychology of habit even farther behind while he draws nearer to the higher values. A great variety of subjects is discussed here, including heredity and progress, stampedes, preaching, the nature of woman, marriage and divorce, autosuggestion and prayer, self-love, and agnosticism.

We have attempted to describe the principal features of this book without criticizing several questionable points of view. The worst fault we have to find is the note of religious pessimism in the suggestion that psychology can never become a science. This is a mistaken view, because psychology is already a science. We also question whether it will become more scientific if "purpose" is accepted as the fundamental category.

HULSEY CASON
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TURNER, E. M., and BETTS, G. H. *Laboratory Studies in Educational Psychology.* N. Y.: Appleton, 1924. Pp. xiv+218.

The book contains 52 experiments intended to cover much of the field of educational psychology and is intended for use in elementary

classes of this subject. For each experiment the authors state the object and follow this up with a paragraph showing the setting of the problem. This is followed by concise mention of materials and of directions for procedure and finally by questions which the student is supposed to answer on the basis of his results.

The topics covered by the experiments are varied and include several general experiments on observation and introspection. These are followed by experiments on attention, sensation, perception, imagery, association and a (properly) large group on memorization and economic methods of learnnig. Then come a series of experiments on instinctive tendencies, heredity, intelligence and achievement tests. Next the authors give some space to feeling and emotion,—why in this place and why in this order cannot be explained by the reviewer. Finally a short paragraph on the statistical handling of educational results closes the volume.

In the opinion of the reviewer, the authors have tried to cover too much of the field in one volume of this size and, as a result, have not been able to give enough space to any one of the topics treated.

University of Pennsylvania SAMUEL W. FERNBERGER

ANTOINETTE FELEKY. *Feelings and Emotions.* N. Y.: Pioneer Pub. Co., 1924. Pp. xv+245.

The author, by reproducing a great number of excellent photographs of facial expression, attempts to analyze emotions and feelings in the way "a chemist analyzes a compound." She believes that to get a proper facial expression a corresponding thought and feeling must exist in the mind of the subject. Hence the book and its numerous illustrations should be of interest to the photographer, painter, sculptor and dramatic artist as well as to the psychologist. The second half of the book records an experimental investigation of the judgment of facial expression. Eighty-six photographs were each judged by 100 people. As one would expect the scatter is great and, in no case, is there a high degree of judgment on the descriptive term which the pose is supposed to represent. The author groups the judgments and thus obtains a higher percentage of correct judgments on grounds that seem to the reviewer to be logical rather than psychological. The book seems to the reviewer to be of interest for psychologists primarily for the large series of excellent photographs which it contains.

SAMUEL W. FERNBERGER
University of Pennsylvania

WATTS, FRANK, M.A. (London). *Abnormal Psychology and Education.* N. Y.: D. Appleton Co., 1924. Pp. 220.

Mr. Watts' book is a sound and smoothly written account of certain trends in psychology, significant for the educative process. It is addressed more especially to the teacher, and here its conciseness and freedom from jargon stand it in good stead. The opening chapter is a historical account of abnormal psychology, in which might well have been included what apparently was the psychological reason for the changed attitude of the early Christians regarding psychopathic phenomena, as affected by moral considerations. There follow some sixty pages which are concerned not so much with abnormal as with social psychology in its applications to educational management. Reaching the central theme in the third chapter, the author collates the principal views concerning dissociation, the growth of this concept, and the causes assigned, concluding with brief remarks on dreams and the association method. The chapter on mental defect is especially good, and the critical discussion of psychometric methods is to the reviewer the best portion of the volume, suggesting that the author would have done well to have given us more of himself, if perhaps less of compilation. The volume concludes with a survey of methods of teaching defectives and their relation to the teaching of normal individuals. As a whole, it is an outline of what abnormal and social psychology have to offer to the educator.

Whether, as such, it is sufficiently distinctive to stand out among the many endeavors to interpret psychology along lines of life-management, is an open question. Few readers will cavil with its substance on factual grounds, except for an allusion (quoted, not the author's) to Abraham Lincoln as the "Father of his country," and to the cycle of myths regarding a "certain type of motor-car . . . their effect has been to influence unthinking persons into the acceptance of the view that the car is quite unreliable." The first of these is understandable as a *Deckerrinerung;* possibly the second is a subtle compliment to the few unthinking persons on this side of the water at least.

F. L. WELLS

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FRANKLIN, EDWARD EARLE. *The Permanence of the Vocational Interests of Junior High School Pupils. Johns Hopkins University Studies in Education,* No. 8. Baltimore, Md.: Johns Hopkins Press, 1924. Pp. vii+61.

The immediate aim of this experimental investigation was to ascertain how permanent and how reliable are the vocational interests of pupils entering the Junior High School. Its ultimate purpose was in the nature of a contribution to the consideration of interests in the vocational guidance of children at the working age level. In October, 1922, about 1,600 pupils entering eight of the ten Junior High Schools in Baltimore were given the Illinois Test, the Mentimeter, the Toopes I.E.R. Clerical Test—form 1, and the Stenquist Mechanical Test—form 1. In addition an interest questionnaire devised for the purpose of studying the vocational, recreational subject-matter, and work interests of the pupil was filled in by the pupils in December, 1922. Three follow-up questionnaires were given—one in May, 1923, a second in October, 1923 (after the summer's vacation), and a third in December, 1923.

These results are statistically analyzed to reveal the permanence of interest, the influence of intelligence upon interest and its permanency, the relation of interest and intelligence to elimination from the high school, etc. Among the conclusions drawn by the author are the following:

The vocational interests of Junior High School pupils show a very high degree of permanence over a period of at least one year—and that a critical one. Two children out of every three have the same preferences at the end of the period as they had at the beginning. The girls' choices are more permanent than the boys'. Intelligence and interest are more prepotent factors in pupil elimination from the Junior High School than economic pressure. Children whose mental capacity is below average furnish twice as large a percentage of withdrawals as they should do if intelligence were a negligible factor. Children with nonprofessional interests are more than twice as likely to be eliminated than are those with professional interests. The vocational interest expressed by the pupil is valid and practical. The interests of clerical pupils are closely correlated with successful school work. Pupils who adhere to clerical interests make much higher scores in a prognostic clerical test than the larger unselected group. Pupils who are to enter a vocation that requires a more

or less lengthy vocational preparation have higher intelligence than those who decide otherwise.

Conclusions with reference to sex differences are of special interest. Among the girls the lower the intelligenc the more likely are they to select clerical work; the higher the intelligence the more likely to select teaching. Those with higher intelligence select vocations other than these two. The occupational opportunities for girls are much more limited than those of boys. A recognition of sex differences in interest and occupational opportunities is essential in adequate guidance.

The study represents a valuable contribution to the consideration of interest in guidance. There is presented significant experimental data combined with a tactful and judicious interpretation of this data. As in the case of the reviewer, some readers will at certain points find themselves in disagreement with an expressed point of view, but such a difference in opinion will not detract seriously from this interesting experimental study. MORRIS S. VITELES

University of Pennsylvania

MARGARET DOUGHERTY and JOSEPHINE MACLATCHY. *Bibliography of Educational and Psychological Tests and Measurements.* Bureau of Education Bulletin, 1921, No. 55. Govt. Printing Office, Washington, D. C., 1924. Pp. ix+233.

A very complete bibliography divided into 5 sections—(1) General, (2) References Covering Particular Tests, (3) References Concerning the Characteristics and Uses of Tests, (4) Uses According to Types of Schools, (5) A List of Tests.

This is the most comprehensive bibliography on tests which has been published and can doubtless be of service to all interested in psychological and educational measurements. This usefulness is somewhat curtailed by an inadequacy of indexing and by a failure to include an index of authors. M. S. VITELES

University of Pennsylvania

WHEELER, WILLIAM MORTON. *Social Life Among the Insects.* N. Y.: Harcourt, Brace, 1923. Pp. vii+375.

In this book are published the six lectures given by the author at the Lowell Institute in Boston, February 27th to March 16th, 1922. The lectures are printed with only slight verbal changes and some amplification.

In the first lecture some remarks are made about insect societies in general, and the social beetles in particular are discussed. The author points out that John Fiske told only part of the truth when he claimed that human society has been rendered possible by the lengthening of infancy and childhood. It is equally true that the adult life of the organism must also be prolonged in order to care for the retarded juvenile development. In fact, in the insects the lengthening of the adult stage comes first and makes social life possible. "In solitary insects, of course, it is just the brevity of adult life that prevents the development of the social habit, no matter how long the larval period may be. This period may, in fact, extend over months or even years in certain insects which have an adult stage of only a few days or hours."

As a result of the lengthening of the adult life there is an increasingly intimate and interdependent relationship set up between the parent insect and its offspring, and we are confronted "with a new organic unit, or biological entity—a super-organism, in fact, in which through physiological division of labor the component individuals specialize in diverse ways and become necessary to one another's welfare or very existence."

As a consequence of this relationship there must be a modification of the activities of the original solitary insects composing the society. These activities are "an expression of three fundamental appetites or appetencies. Two of these—hunger and sex—are positive and possessive, the other—fear or avoidance—is negative and avertive. These appetites appear as the needs for food, progeny and protection." The author does not digress at this point to explain just what he means by the term "appetite." Such a digression seems rather necessary for the sake of clarity when he commits the anomaly of terming fear an appetite. The need for this clarification is again felt a little further on when he says that the whole life-cycle of an insect "may consist of a few appetitive cycles of very elaborate patterns—the so-called 'instincts.'"

The author goes on to explain that these fundamental appetites are modified by the social relationship. The organism becomes "socially sensitized, and all its appetites and emotions become hypertrophied or even perverted." Thus in the transition from the solitary to the social life the satisfaction of the hunger appetite becomes increasingly difficult. The social insects, as pointed out by the author,

have overcome this difficulty in a number of ways. The same is true with reference to the other appetites mentioned.

Wheeler draws a parallel between human and insect societies. He discusses six of the differences which various writers have professed to find between the two. It seems to the reviewer that the author is successful in maintaining his parallel despite these so-called differences. It is, of course, true that he does not find any one insect society which will parallel human society in every respect, but he does show that, in every respect, human society is paralleled by one or more insect societies. The only difference which is not so satisfactorily disposed of is the one relating to language. The human being has developed language and it is true that members of an insect society seem to communicate with one another, but the gulf between human communication and that maintained by the insects is, as we see it, so vast that the parallel between the two is rather far fetched.

But, regardless of the linguistic dissimilarity between human and insect societies, we are ready to agree with the author that, "the wonder has always been, not that there are so many differences in structure between such disparate organisms as insects and man, but that there are so many striking similarities in behavior. And the wonder grows when we find that social organization at least incipiently analogous to our own has arisen *de novo* on at least 24 different occasions in nearly as many natural families or subfamilies belonging to five very different orders of insects."

From this point the author proceeds to discuss a number of these 24 different insect societies. He endeavors, according to his own statement, "to throw emphasis on the fundamental nutritive *motifs* in the phylogeny, ontogeny, and maintenance of insect societies." The material which he presents in the fourth and fifth lectures is in part new and in part a summary of his former volume, "Ants, their Structure, Development and Behavior."

It is impossible, within the scope of this review, to summarize all the facts and observations which are recorded in these six lectures on the Social Beetles, Solitary and Social Wasps, Solitary and Social Bees, Ants and Ant Guests, and the Termites. It will be of interest, however, to summarize the various ways in which the author finds that the nutitive *motif* works out to bring about social life among the insects.

These ways may be summarized as follows:

1. The food of the insect may be abundant but not very nutritious,

so that the adequate exploitation of the supply has necessitated a lengthening of the adult life of the insect. " This in turn has naturally brought about an overlapping of the juvenile by the parent generation, thus enabling the parents to acquire contact and acquaintance with their young and an interest in providing them with the same kind of food as that on which they themselves habitually feed."

2. The food may be highly nutritious but obtainable in only small quantities at a time with the same results as noted under 1.

3. Seasonal and local conditions of the environment sometimes occur which cause the insect to abandon its " mass provisioning " of the larvae and reduce it to " progressive provisioning." Thus, it is the habit of certain solitary wasps to make a cell, place an egg in it, and fill the rest of the cell with spiders or other food, and then to seal the cell. But if climatic conditions make the supply of the proper food inadequate the egg hatches before the cell has been filled and sealed. This obliges the mother to continue bringing food which is eaten almost as fast as brought by the growing young. This circumstance forms a " very primitive family, or society, reduced to its simplest terms, *i.e.*, a mother and her single offspring."

4. The conditions described above under 3 may indirectly be the cause of the formation of a large and complex society through the intervention of another phenomenon which Wheeler terms " trophallaxis." By being thrown in contact with its larva the adult insect may learn that this is not a one-sided benefit, for the larva in many species produce a fluid in its salivary glands which is relished by its mother. " Thence naturally follows a tendency to increase the number of larvae to be reared simultaneously in order at the same time to satisfy the urgency of oviposition and to profit by the greater abundance of the secretion of the larvae." This interchange of food between individuals is trophallaxis. This phenomenon, Wheeler thinks, will explain not only the formation of certain insect societies but also the relationships of these insects with certain other insects and with certain plants.

Wheeler goes on to discuss parasitism with special reference to ants. He shows how social life tends to produce parasitism among all social animals. The ideal society would be one in which all members are mutually and equally helpful to each other. Such an ideal state seldom exists and some members are exploited while the others become correspondingly dependent or parasitic. This con-

dition is so serious in human society that it is "responsible for the small amount of free creative activity in many nations."

The series of lectures closes with a very interesting one on the Termites or "White Ants." At the end of the book there are 70 pages devoted to a documentary appendix which should prove very valuable to those who wish to make a more extensive study of the social insects. The author has apparently spared no pains in the compilation of this appendix and the references in foreign languages are given as well as those in English.

The reviewer has attempted to give briefly some of the outstanding points of this most interesting and instructive book. The social psychologist, especially, should find this volume useful as source of illustrations and of principles with which to clarify and explain phenomena of human society.

It is true, of course, that the author violates in some of his language the mandates of the scientists who examine animal life from a purely psychological standpoint. For example, he says that the "mother wasp *may be aware,* (italics mine) not only of sexual differences among her own eggs, but also of the differences in the amount of food required by the resulting larvae." Or again he speaks of certain wasps as showing "more interest" in the welfare of their progeny than is implied in the mere mass provisioning of their cells. But one should remember that these lectures are written in a more or less popular form and when so writing it is almost impossible to escape all phrases of an anthropomorphic implication.

The author uses a delightfully lucid and easy style in his writing which adds a great deal to the intrinsic interest of the subject-matter and facilitates the reading of the book by those who are not initiated into the mysteries of entomology.

It is the reviewer's opinion that anyone may read this book with pleasure and profit, and that it should be particularly valuable to those especially interested in the phenomena of human society.

W. T. HERON

University of Kansas

GATES, ARTHUR I. *Elementary Psychology.* N. Y.: Macmillan, 1925. Pp. xiv+594.

After a discussion of the general methods of science, Gates establishes the mechanisms in the nervous system which are to form the basis for his future discussion of conscious and non-conscious reac-

tions of the organism. In Chapter V the author considers the question of native equipment and thus clears the ground for his systematic presentation. Sensations and Feelings, as the elementary processes of consciousness, are described and then follows the problem of the Emotions. This naturally leads to the problem of the dominant human urges and to their rôle in habit formation. The next three chapters contain a discussion of the learning problem. Then follows two chapters on perception and the higher mental processes and this is followed by a chapter on mental organization and the transfer of training. Then follow, in order, the influence of internal and external conditions upon efficiency; the nature of individual differences; intelligence and finally the measurement, organization and significance of various human traits.

This books is very clearly written at about the level one expects for an elementary text. In the opinion of the reviewer, the choice of material is excellent. The chapters on the physiological background of behavior are especially well and interestingly written and are illustrated with very helpful diagrams. The chapters on motivation are up to date and the author has here handled, in admirable fashion, a treatment which is difficult. It seems that a great deal of space has been given to the learning problem. Many new illustrations appear throughout the book. At the end of each chapter are given well selected lists of references and series of questions. The author here shows his psychological training by introducing forms of true-false, multiple choice and other forms of examination.

SAMUEL W. FERNBERGER

University of Pennsylvania.

BOOKS RECEIVED

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NOTES AND NEWS

In 1924 the Research Information Service of the National Research Council sent to about 200 libraries in the United States copies of a reprint of the "List of Periodicals" from the *Psychological Index*, No. 29, for 1922 (published in May, 1923), with the request that the libraries would check the journals currently received by them. From the copies which were checked and returned a compilation of the foreign serials currently received in libraries in the United States has been made as an aid to investigators in binding the journals cited in *Psychological Index* and in other bibliographical sources. This report is now in mimeographed form and a limited number is available for distribution upon application to the Research Information Service, National Research Council, B and 21st Streets, Washington, D. C.

Dr. Clark Wissler, professor of anthropology in the Yale Institute of Psychology, will leave soon for Hawaii and Australasia to visit scientific institutions and familiarize himself with the progress of anthropological research in these countries.

At Yale University Dr. William C. Trow, associate professor of educational psychology at the University of Cincinnati, has been appointed visiting professor of educational psychology and Dr. Edward A. Bott, associate professor of psychology in the University of Toronto, visiting associate professor of psychology.

Dr. Richard H. Paynter and Dr. Phyllis Blanchard, psychologists of the All-Philadelphia Child Guidance Clinic, have been appointed instructors of psychology in the graduate school of medicine of the University of Pennsylvania.